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ADVANCED PROPULSION CONCEPTS AND COMPONENT TECHNOLOGIES

Jeffrey S. Stutrud

**Combustion Branch
Turbine Engine Division**

JULY 2007

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*//Signature//

JEFFREY S. STUTRUD
Program Manager
Combustion Branch

//Signature//

ROBERT D. HANCOCK, Ph.D.
Chief
Combustion Branch

//Signature//

JEFFREY M. STRICKER
Chief Engineer
Turbine Engine Division

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14. ABSTRACT This technical memorandum summarizes the activities of a cost-shared project order entitled “Advanced Propulsion Concepts and Component Technologies” dated 14 June 2004 under an AFRL MOU/PIA (Memorandum of Understanding/Partnership Intermediary Agreement) dated 17 March 2003 with the Wright Brothers Institute (WBI) located in Dayton, Ohio. The program was structured as a one year effort to develop a plan for cooperative research partnered with The Ohio State University. An optional four year follow-on effort may be pursued to conduct the proposed research. The objective and scope of this research was to define and investigate advanced propulsion concepts and component technologies that could provide improvements in gas turbine engines and advanced propulsion systems for manned and unmanned systems to enhance the mission of PR. This could include technologies associated with gas turbine engines, combined cycle engines, near-constant temperature cycle turbine engines, and pulsed detonation engines or other related areas of interest to the Air Force.					
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Executive Summary

The objective of this effort was to define and investigate advanced propulsion concepts and component technologies through a cost-shared collaboration between the Air Force Research Laboratory Propulsion Directorate, The Ohio State University and the Wright Brothers Institute. These concepts and technologies are intended to enhance the mission of the Propulsion Directorate.

This program did not progress beyond the planning stages due to the competitive ranking of this effort with other Propulsion Directorate programs.

Introduction

This technical memorandum summarizes the activities of a cost-shared project order entitled "Advanced Propulsion Concepts and Component Technologies" dated 14 June 2004 under an AFRL MOU/PIA (Memorandum of Understanding/Partnership Intermediary Agreement) dated 17 March 2003 with the Wright Brothers Institute (WBI) located in Dayton, Ohio. The Air Force Research Laboratory headquarters (AFRL) provided \$100K seed money to establish this project order to be administered by WBI and would team the Propulsion Directorate (AFRL/PR) with The Ohio State University (OSU) to analyze and investigate advanced propulsion concepts and their associated component technologies. OSU has expertise in a wide variety of advanced propulsion technologies that are critical to the Air Force. As designed, this program would improve the rapid development and evaluation of advanced propulsion systems and components for the Air Force. The goal of this program was to combine AFRL and OSU resources to develop, evaluate, and eventually transition advanced propulsion technologies to the various operational command elements of the Air Force.

The program was structured as a one-year effort to develop a plan for research with the possibility of a four-year follow-on effort to conduct the proposed research. The objective and scope of this research was to define and investigate advanced propulsion concepts and component technologies that could provide improvements in gas turbine engines and advanced propulsion systems for manned and unmanned systems to enhance the mission of PR. This could include technologies associated with gas turbine engines, combined cycle engines, near-constant temperature cycle turbine engines, and pulsed detonation engines or other related areas of interest to the Air Force.

The overall financial contribution of the Air Force for the full five-year effort would be \$500K. In this 50/50 partnership, OSU would contribute an additional \$500K. As the Air Force programmed financial contribution decreased over the programs life, the OSU contribution would increase, resulting in a fairly constant level of effort. OSU "in-kind" contributions were permitted in-lieu of monetary contributions.

The WBI Principle Investigator was Dr. Meyer J. Benzakein, former General Electric Company general manager for Advanced Engineering responsible for research and development activities on all new commercial and military product lines at General Electric Aircraft Engines. Currently Dr. Benzakein is the chair of Aerospace Engineering Department in the College of Engineering at The Ohio State University and WBI Professor.

Program Milestones and Events

In December 2004, as a means of introduction to the Air Force Research Laboratory (AFRL), Dr. Benzakein, the Wright Brothers Institute (WBI) Professor, chair of Aerospace Engineering at the Ohio State University (OSU) and principle investigator for this collaboration project order, gave a presentation to the assembled members of AFRL entitled, "New Product Introduction - The commercial experience at GE (General Electric) and how it can be applied to military engine development." The presentation discussed the disciplines associated with new product introduction at GE reviewing the THRUPUT initiatives of the late 1990's. These initiatives reduced engine development cycle from 60 to 24 months.

In February 2005, PR hosted an Ohio Center for Advanced Propulsion and Power (OCAPP) meeting to present OCAPP capabilities to AFRL in the areas of acoustics, bearings, combustion, materials, sensors and turbo-machinery. Discussions were also held on the development of a Propulsion Center of Excellence at OSU.

During March 2005, meetings were scheduled for Dr. Benzakein with technology leaders from the Propulsion Directorate (PR). The purpose of these meetings was to lay the ground work for the development of a plan where the OSU efforts, along with OCAPP studies, could be used to develop and evaluate advanced propulsion concepts that could provide improvements for gas turbine engines and advanced propulsion systems for manned and unmanned applications that would be of interest to PR. At these meetings PR personnel discussed current technology needs.

In April 2005, as a result of those meetings, Dr. Benzakein drafted and submitted to the Combustion Branch (PRTC) potential areas of interest for consideration as Task II program elements. Whereas these six topics did not provide the technology push desired by PR, PRTC recommended that a customer need-based program be proposed that would concentrate on the development of a small engine in a lower thrust class or less than 50 HP class. Such a program could both benefit student researchers at OSU and the Air Force.

In June 2005, a meeting was scheduled at the WBI offices to discuss the possibilities of a customer need-based program. Choices of a small gas turbine or a small diesel engine were discussed at the meeting. Professors Benzakein, Haritonidis and Rizzoni attended from OSU. Dr. Barthelemy attended for WBI. AFRL attendees included PRP and PRT representatives. As a result, it was decided that the University would reexamine the different possibilities.

As a follow up to this meeting, Professors Benzakein and Haritonidis conducted a site visit to Turbine Technologies LTD in Chetek, Wisconsin. Turbine Technologies is the designer and producer of a small turbojet engine in the desired class. The SR-30 engine was designed by Turbine Technologies as a teaching and or training tool for academic institutions. OSU currently owns and operates a SR-30 for tutorial purposes.

In late June 2005, Dr. Benzakein submitted a preliminary proposal to use the SR-30 as a development vehicle in a multiphase program which was critiqued by PRTC. PRTC stated that the Air Force has no particular interest in a program to characterize the SR-30 and stated that many academic organizations, as well as the Air Force Institute of Technology (AFIT), have already performed this work.

In late July 2005, PRTC again suggested a customer need-based program such as the proposed engine systems under development for the Air Combat Command or Air Armament Command. PRTC discussed ways to strengthen the draft proposal and asked Dr. Benzakein to submit a formal proposal through WBI.

Conclusion

The Task II proposal, entitled “Cooperative Proposal for Advanced Propulsion Concepts” was received 30 September 2005 from WBI. This proposal focused on upgrade of the OSU owned SR-30 and characterization of the engine including life cycle prediction of the different engine components. Engine simulation computer codes and performance characterization computer codes to correlate engine data, including noise and species emission data would also be developed. The final objective of the proposed research was to provide an optimized SR-30 engine through the parametric studies of the baseline engine and redesign of the engine components to provide a potential product for an Air Force command element and or possible marketing by Turbine Technologies. After review of the proposal by Air Force personnel and management it was decided not to proceed with Task II of the project order.

The rationale for not exercising the four optional years of the project order is based upon an internal funds competition ranking of this effort against other obligations for the subject fiscal years under the current fund allocations. The program’s goal, to evaluate and improve Turbine Technologies’ SR-30 for deployment in some future customer platform, is very high risk and the value of this program for the Air Force is unclear. The risk assessment is also based on the lack of letters of support from industry or proposed customer.

The program ended 31 December 2005 with the completion of Task I.